



June 2, 2022
PanGEO Project No. 21-094

Mr. John Babb
Gray and Osborne, Inc.
2102 Carriage Drive SW, Bldg. I
Olympia, Washington 98502

Subject: Supplemental Report - Landslide Hazard Review
 Carbon Treatment Facilities
 Bell Hill and Hoffman Hill, DuPont, Washington

Dear Mr. Babb:

This letter summarizes the results of our landslide hazard review for the project sites, based on review comments from the City's reviewer. This review was requested by the City because the proposed improvements appear to be located near or in areas with slopes greater than 15% gradient that may be considered as landslide hazard areas.

The letter should be considered a supplement to our report dated April 21, 2021. The recommendations outlined in our 2021 report remain applicable.

EVALUATION OF LANDSLIDE HAZARD CRITERIA

The following outlines our evaluation of the criteria that define landslide hazards, in accordance with the DMC 25.105.050(3)(a). Our assessment/response are in red.

BELL HILL SITE

DMC 25.105.050(3)(a) Classification. For purposes of this chapter, geologically hazardous areas shall include all of the following:

(i) Landslide Hazard Areas. Landslide hazard areas shall include areas potentially susceptible to landslides based on a combination of geologic, topographic, and hydrologic factors. They include any areas susceptible to mass movement due to any combination of

bedrock, soil, slope (gradient), slope aspect, slope form (concave, convex, planar), geological structure, surface and subsurface hydrology, or other factors. Landslide hazard areas shall also include areas along which landslide material may be routed or which may be subject to deposition of landslide delivered material. Landslide hazard areas include but are not limited to the following areas:

(A) Areas designated as quaternary slumps, earth-flows, mudflows, or landslides on maps published by the U.S. Geological Survey, Washington State Department of Natural Resources, or other reputable sources;

According to the DNR Website, an area located downslope of the proposed Carbon Treatment facility at Bell Hill is mapped as susceptible to shallow instabilities. However, the area of the proposed construction is not mapped as susceptible to slope instabilities.

No sign of landslide scarps is located in the area, and the slope is not mapped as susceptible to deep-seated failures.

The mapped surficial landslide risk, or surficial sloughing, is likely due to the steepness of the slope. Any surficial instabilities on the slope should not extent into the proposed construction area.



Bell Hill Site - Mapped landslide susceptibility (source: Washington State Department of Natural Resources)

(B) Areas with all three of the following characteristics:

- (I) Slopes steeper than 15 percent; **Yes**
- (II) Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; **This condition does not present on site.**
- (III) Springs or ground water seepage; **Not Observed.**

In summary, the site slopes do not meet all the characteristics outlined above.

(C) Areas that have shown movement and/or are underlain or covered by mass wastage debris; Test pits completed at the site encountered native Steilacoom Gravel near the ground surface. **No evidence of mass wastage debris was observed on site, based on the results of our test pits excavated at the site.**

(D) Potentially unstable slopes resulting from river or stream erosion or undercutting by wave erosion; **This condition not present.**

(E) Areas that show past sloughing or calving of sediment or rocks resulting in a steep slope that is poorly vegetated; **This condition not present, based on review of LiDAR imagery.**

(F) Slopes that are parallel or sub-parallel to planes of weakness (which may include but not be limited to bedding planes, soft clay layers, joint systems, and fault planes) in subsurface materials; **This condition not present, based on test pits and review of geology maps.**

(G) Any area with a slope of 40 percent or steeper and with a vertical relief of 10 or more feet except areas composed of competent bedrock or a properly engineered slope designed and approved by a geotechnical engineer licensed in the state of Washington and experienced with the site;

The existing slope adjacent to the construction area is between 40 and 50% gradient and is taller than 10 feet. However, based on the review of LiDAR image (below), we believe that the slope was created by previous grading activities associated with the construction of the existing facility. Since the slope immediately adjacent to the proposed construction area was graded to no steeper than 2H:1V (i.e., 50% slope), which is consistent with the current standard of practice for competent soils, the slope should not be considered a landslide hazard area.



Bell Hill Site – LiDAR Imagery

(H) Areas within which land use activities could affect the slope stability, including but not limited to areas with subsurface hydrologic flow, ground water recharge areas and surface water flow; **This condition not present, since land use activities will remain the same.**

(I) Areas of historical landslide movement including coastal shoreline areas mapped by the Department of Ecology Coastal Zone Atlas or the Department of Natural Resources slope

stability mapping as unstable (“U” or class 3), unstable old slides (“UOS” or class 4), or unstable recent slides (“URS” or class 5). This condition not present, based on review of LiDAR imagery and landslide inventory obtained from Department of Natural Resources.

(ii) Erosion Hazard Areas. Erosion hazard areas shall include:

(A) Channel migration zones, also known as riverine erosion areas, are defined as the areas along a river or stream within which the channel(s) can be reasonably predicted to migrate over time. This is a result of natural and normally occurring geomorphic, hydrological, and related processes when considered with the characteristics of the river or stream and its surroundings, and in consideration of river and stream management plans. Channel migration hazard areas shall include: potential channel migration, channel avulsion, bank erosion, and stability of slopes along the river or stream; **This condition not present.**

(B) Coastal erosion areas that are subject to shoreline retreat from wind, wave, and tidal erosion. **This condition not present.**

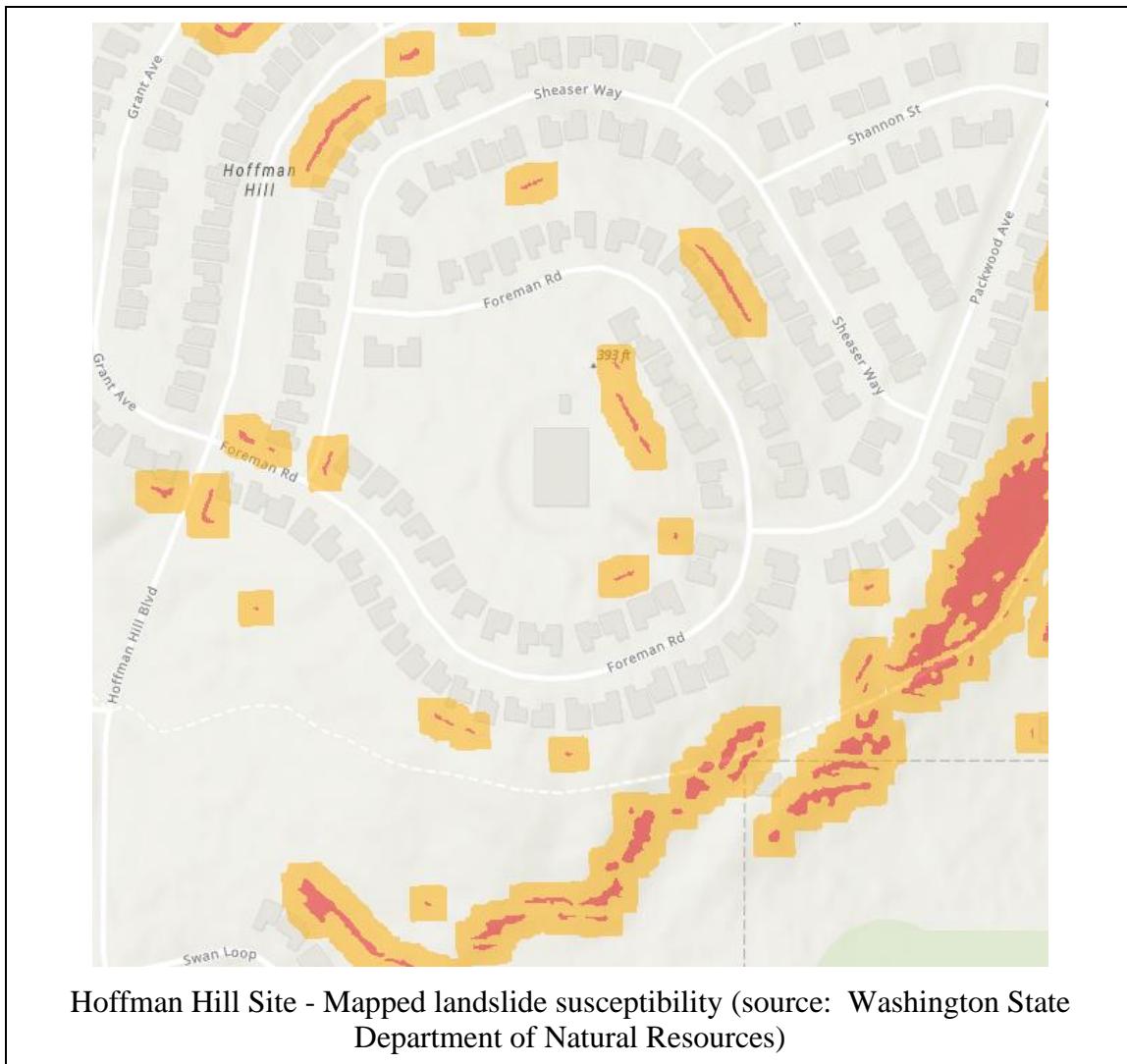
HOFFMAN HILL SITE

(A) Areas designated as quaternary slumps, earth-flows, mudflows, or landslides on maps published by the U.S. Geological Survey, Washington State Department of Natural Resources, or other reputable sources;

According to the DNR Website, the area located downslope of the proposed Carbon Treatment facility at Hoffman Hill is mapped as susceptible to shallow instabilities (i.e., surficial sloughing and erosions), but not at risk of deep-seated landslides. No signs of landslide scars are located in the area

The area of the proposed construction is not mapped as susceptible to slope instabilities.

The mapped surficial landslide risk located downslope of the construction area is likely due to the steepness of the slope. Any surficial instabilities on the slope should not extend into the proposed construction area.



(B) Areas with all three of the following characteristics:

- (I) Slopes steeper than 15 percent; **Yes**
- (II) Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; **This condition not present.**
- (III) Springs or ground water seepage; **Not Observed.**

In summary, the site slopes do not meet all the characteristics outlined above.

(C) Areas that have shown movement and/or are underlain or covered by mass wastage debris; Test pits completed at the site encountered native Steilacoom Gravel near the ground surface. **No evidence of mass wastage debris was observed on site, based on the results of our test pits excavated at the site.**

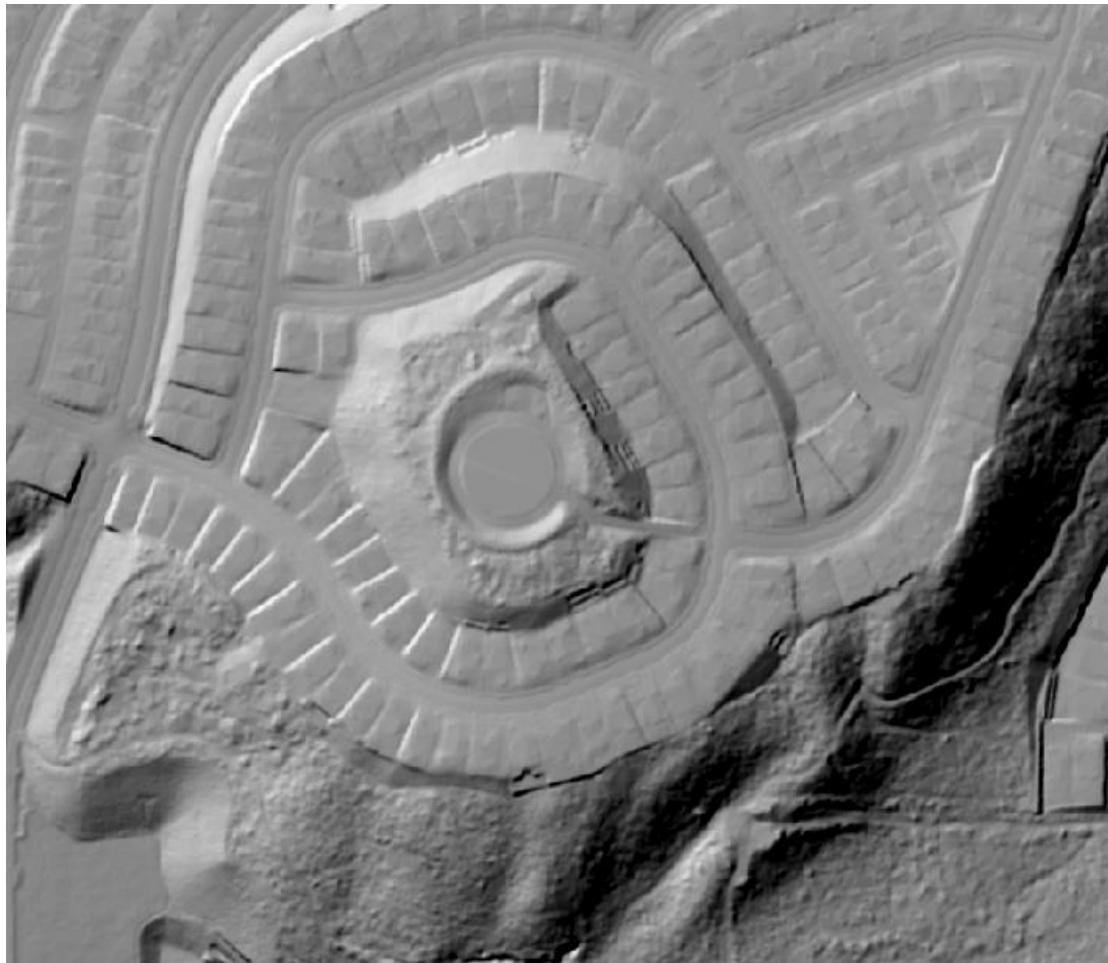
(D) Potentially unstable slopes resulting from river or stream erosion or undercutting by wave erosion; **This condition not present, based on our review of LiDAR imagery.**

(E) Areas that show past sloughing or calving of sediment or rocks resulting in a steep slope that is poorly vegetated; **This condition not present.**

(F) Slopes that are parallel or sub-parallel to planes of weakness (which may include but not be limited to bedding planes, soft clay layers, joint systems, and fault planes) in subsurface materials; **This condition not present, based on test pits and review of geology maps.**

(G) Any area with a slope of 40 percent or steeper and with a vertical relief of 10 or more feet except areas composed of competent bedrock or a properly engineered slope designed and approved by a geotechnical engineer licensed in the state of Washington and experienced with the site;

The slope in question is located between the project site and the residential dwellings located below and east of the site. Based on the review of LiDAR image (below), the slope surface is very uniform and appears artificial. It is our opinion that the slope was previously graded, likely associated with the construction of the existing houses. The slope was graded no steeper than 2H:1V (i.e., 50% slope) based on Pierce County mapping. Since the slope was previously designed and graded to a slope gradient that is consistent with the current standard of practice for competent soils, the slope should not be considered a landslide hazard area.



Hoffman Hill Site – LiDAR Imagery

(H) Areas within which land use activities could affect the slope stability, including but not limited to areas with subsurface hydrologic flow, ground water recharge areas and surface water flow; **This condition not present, as land use activities will remain the same.**

(I) Areas of historical landslide movement including coastal shoreline areas mapped by the Department of Ecology Coastal Zone Atlas or the Department of Natural Resources slope stability mapping as unstable (“U” or class 3), unstable old slides (“UOS” or class 4), or unstable recent slides (“URS” or class 5). **This condition not present, based on review of LiDAR imager and landslide inventory from the Department of Natural Resources.**

(ii) Erosion Hazard Areas. Erosion hazard areas shall include:

(A) Channel migration zones, also known as riverine erosion areas, are defined as the areas along a river or stream within which the channel(s) can be reasonably predicted to migrate over time. This is a result of natural and normally occurring geomorphic, hydrological, and related processes when considered with the characteristics of the river or stream and its surroundings, and in consideration of river and stream management plans. Channel migration hazard areas shall include: potential channel migration, channel avulsion, bank erosion, and stability of slopes along the river or stream; **This condition not present.**

(B) Coastal erosion areas that are subject to shoreline retreat from wind, wave, and tidal erosion. **This condition not present.**

CONCLUSIONS

In summary, based on our evaluation, it is our opinion that the landslide risks at the projects are negligible. Potential surficial instabilities on slopes located in the vicinity of site are not expected to impact the project sites. In addition, it is also opinion that the proposed improvements will have no impacts to the stability of the adjacent slopes. As such, it is our opinion that no additional measures are needed to improve the stability of the sites for the current projects.

We appreciate the opportunity to be of service. Should you have any questions, please do not hesitate to call.

Sincerely,



Siew L. Tan, P.E.
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